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COMMITTEE OF EXPERTS ON THE TRANSPORT
OF DANGEROUS GOODS

Sub-Committee of Experts on the
Transport of Dangerous Goods

REPORT OF THE SUB-COMMITTEE OF EXPERTS ON ITS FIFTEENTH SESSION

(Geneva, 29 June-9 July 1998)

Addendum 1

Annex 1

General

1. The Working Group on tanks for non-refrigerated gases with a critical temperature below 65 °C met from 29 June to 2 July 1998 under the chairmanship of Mr. H. Puype (European Industrial Gases Association ((EIGA)). Experts from France, Germany, Sweden, the United Kingdom, the United States of America and EIGA participated in the meeting.

2. After a general discussion on the outcome of the preceding session, the Working Group decided to take as basis for discussion the EIGA submission ST/SG/AC.10/C.3/1998/46 taking into account the remarks from the expert of the United States of America in ST/SG/AC.10/C.3/1998/33.

Consideration on the basic proposal ST/SG/AC.10/C.3/1998/46 (EIGA)

3. The Working Group agreed that EIGA should make a proposal for the next session to modify the definitions in chapter 2.2.1 for the transport conditions of a gas to take into account the filling provisions. A draft proposal based on the ISO TC58 Technical report 9719-2 was circulated at the meeting.

4. The Working Group re-discussed the issue of very toxic gases and confirmed that toxic gases and gas mixtures with [a LC_{50} < 200 ppm] should not be authorised for transport in multiple-element gas containers (MEGC). The Working Group took note of INF.26 of OECD that the latest value proposed is 250 ppm/1h (125 ppm/4h).

5. The Federal Institute for Materials Research and Testing (B.A.M.) (Germany) confirmed the filling and test pressure data of table T51. The group decided to change:

- all "forbidden" positions into "normal" as none of these gases have an LC_{50} lower than 200 ppm/1h;

- the pressure relief requirement for 2203 Silane, compressed from "normal" into "not allowed" due to its pyrophoric nature.

6. The Working Group proposes to the plenary that the tables T51, T50, T60 and T75 include all gases belonging to their respective groups. EIGA offered to submit in due time for the next sessions the said tables. If the proposal of the working group is accepted 6.6.1.3 becomes redundant.

7. The Working Group agrees with the principle that the requirements for the design, construction, inspection and testing for the elements should be addressed in section 6.2.1. However, since no such requirements are available yet, it was decided to maintain a set of provisions in this section. The Working Group encourages concertation between the experts of the Unites States of America and of EIGA to propose such requirements for the next biennium.

8. The Working Group discussed extensively the required definitions with regard to pressure for the MEGC. It was agreed to delete the MAWP as design and filling requirements are based on test pressure. New definitions of "test pressure", "settled pressure" and "working pressure" inspired by the ISO definitions have been proposed.

9. The working group fixed the value for effective internal pressure during leakproofness test at 20% of the test pressure instead of 25% of the MAWP. This is a consistent approach with the requirements for the other portable tanks for gases where the test pressure equals 1.3 times the MAWP.

10. The sections dealing with general design and construction requirements and design criteria for the elements have been combined and reworded with an addition of relevant essential safety requirements. Further consideration is necessary and therefore the text has been put between square brackets.

11. The expert from the United States of America proposed to make a reference to the work done at ISO on quality control systems to facilitate mutual recognition including third party conformity assessments of initial testing. This proposal was put between square brackets to allow further investigation.

12. An additional provision for the securing of the elements in the structure of the MEGC was deemed necessary.

13. The limit of 5000L for the installation of an isolation valve for the transport of flammable gases was re-discussed and a modified text was proposed by the expert from the United States of America. This proposal was put between square brackets.

14. The design pressure of the service equipment and of the manifold was replaced by the rated pressure and fixed at two thirds of the test pressure of the elements.

15. The Working Group could not yet reach an agreement on the mandatory fitting of pressure relief devices. The Working Group noted that the matter of fire engulfment will be brought up at the September 1998 meeting of the IMO Working Group on tanks. The expert from the United States of America will re-discuss the matter in view of the proposed changes to the Federal Regulations. EIGA questioned the validity of the hitherto retained parameters for fire engulfment for deck cargo. EIGA also recommended that the decision to fit pressure-relief devices should be based on a global risk analysis.

16. The Working Group agreed to include reference to the CGA pamphlets S-1.1-1994 to cover the capacity of relief devices for compressed gases when fitted.

17. The Working Group decided to eliminate the requirements for closing of the fork lift pockets since they bear no relevance to the MEGC.

18. The Working Group agreed that a design approval could be waived when new MEGCS are fabricated identically to approved designs but with shorter elements of the same construction.

19. The Working Group could not decide to eliminate the test requirements for the 4g impact test. The necessity of testing for this requirement for MEGC's was questioned and the whole paragraph was put between square brackets depending on further investigation.

20. The Working Group agreed that the periodic inspection of the elements should follow the requirements for receptacles. The intermediate inspection at 2.5 years was questioned as to its relevance for MEGC's. The group could not reach a decision and decided to put the provisions between square brackets.

21. The texts as proposed by the Working Group so far is reproduced hereafter.

* * *

4.2.4 General provisions for the use of multiple-element gas containers (MEGCs)

4.2.4.1 This section provides general requirements applicable to the use of multiple-element gas containers (MEGCs) for the transport of non-refrigerated gases.

4.2.4.2 MEGCs shall conform to the design, construction, inspection and testing requirements detailed in 6.6.5.

Gases with a critical temperature below -50 °C shall be transported in multiple-element gas containers conforming to MEGC instruction T60.

Gases with a critical temperature between -50 °C and 65 °C shall be transported in multiple-element gas containers conforming to MEGC instruction T51.

Gases with a critical temperature above 65 °C shall be transported in multiple-element gas containers or portable tanks conforming to portable tank/MEGC instruction T50.

In addition the special provisions for MEGCs assigned to specific gases in column 11 of the Dangerous Goods List and described in 4.2.5.3 shall be complied with.

NOTE: Gases with a critical temperature below -50 °C and which are partially liquid because of their low temperature, shall be transported in accordance with portable tank instruction T75.

4.2.4.3 During transport, MEGCs shall be adequately protected against damage to the elements and service equipment resulting from lateral and longitudinal impact and overturning. If the elements and service equipment are so constructed as to withstand impact or overturning they need not be protected in this way. Examples of such protection are given in **6.6.5.11.5**.

4.2.4.4 Certain gases are chemically unstable. They are accepted for transport only when the necessary steps have been taken to prevent their dangerous decomposition, transformation or polymerization during transport. To this end, care shall in particular be taken to ensure that MEGCs do not contain any gases liable to promote these reactions.

4.2.4.5 Toxic gases and gas mixtures classified under N.O.S. entries of Division 2.3 with an $LC_{50} < 200$ ppm shall not be authorised for transport in MEGCs.

4.2.4.6 Unless the name of the dangerous goods being transported appears on the metal plate described in 6.6.5.14.1, a copy of the certificate specified in 6.6.5.12.1 shall be made available upon a competent authority request and readily provided by the consignor, consignee or agent, as appropriate.

4.2.4.7 Empty MEGCs not cleaned and not gas-free shall comply with the same requirements as MEGCs filled with the previous gas.

4.2.4.8 Filling

4.2.4.8.1 Prior to filling the shipper shall ensure that the MEGC is approved for the gas to be transported and that the MEGC is not loaded with gases which in contact with the materials of the elements, gaskets and service equipment, are likely to react dangerously with them to form dangerous products or appreciably weaken the material. During filling, the temperature of the gas shall fall within the limits of the design temperature range.

4.2.4.8.2 Elements intended for the transport of gases having a critical temperature between -50 °C and 65 °C shall be filled so that, when the elements are filled to the maximum mass of the contents per litre of capacity, the pressure reached in the elements by the substance at 65 °C does not exceed the test pressure.

Elements intended for the transport of gases having a critical temperature above 65 °C shall be filled so that the maximum mass of non-refrigerated liquefied gas per litre of element capacity (kg/l) does not exceed the density of the non-refrigerated liquefied gas at 50 °C multiplied by 0.95. Furthermore, the element shall not be liquid-full at 60 °C. The test pressure will be at least equal to the vapour pressure of the liquid at 65 °C minus 1 bar.

Elements used for the transport of gases having a critical temperature below -50 °C shall be filled so that the internal pressure at 15 °C in the elements does not exceed two thirds of the test pressure.

4.2.4.8.3 Multiple-element gas containers shall not be filled above their maximum permissible gross mass. The maximum permissible load mass or maximum working pressure at 15 °C specified in tables T50, and T51 and T60 for each gas to be transported shall not be exceeded.

4.2.4.8.4 Toxic gases of division 2.3 shall only be transported in multiple-element gas containers where each element is equipped with an isolation valve. The isolation valves shall be closed after filling and remain closed during transport.

4.2.4.9 MEGCs shall not be offered for transport:

(a) when leaking;

(b) when damaged to such an extent that the integrity of the elements, the lifting or securing arrangements may be affected; and

(c) unless the service equipment has been examined and found to be in good working order."

Renumber existing section 4.2.4 as 4.2.5 and renumber accordingly sub-sections and paragraphs therein.

Amend existing 4.2.4 and 4.2.4.1 to read as follows:

"4.2.5 Portable tank and multiple-element gas container (MEGC) instructions and special provisions

4.2.5.1 General

This section includes the portable tank and MEGC instructions and special provisions applicable to dangerous goods authorised to be transported in portable tanks and multiple-element gas containers. Each instruction is identified by an alpha-numeric designation (T1 to T75). Column 10 of the Dangerous Goods List in Chapter 3.2 indicates the portable tank/MEGC instruction that shall be used for each substance permitted for transport in a portable tank or MEGC. When no instruction appears in column 10 for a specific dangerous goods entry then transport of the substance in portable tanks or MEGCs is not permitted unless a competent authority approval is granted as detailed in 6.6.1.3. Portable tank and MEGC special provisions are assigned to specific dangerous goods in column 11 of the Dangerous Goods List in Chapter 3.2. Each portable tank/MEGC special provision is identified by an alpha-numeric designation (TP1 to TP24). A listing of the portable tank/MEGC special provisions is provided in 4.2.5.3.

4.2.5.2 ***Portable tank and MEGC instructions***

4.2.5.2.1 Portable tank and MEGC instructions apply to dangerous goods of Classes 2 to 9. Portable tank and MEGC instructions provide specific information relevant to portable tanks and MEGC requirements applicable to specific substances. These requirements shall be met in addition to the general requirements in this Chapter and Chapter 6.6.

4.2.5.2.2 For substances of Classes 3 to 9, the portable tank instructions (T1 - T34) indicate the applicable minimum test pressure, the minimum shell thickness (in reference steel), bottom opening requirements and pressure relief requirements. In T34, Division 5 2, organic peroxides permitted to be transported in portable tanks are listed along with applicable control and emergency temperatures.

4.2.5.2.3 Gases with critical temperatures above 65 °C are assigned to portable tank/MEGC instruction T50. T50 provides the maximum allowable working pressures, bottom opening requirements, pressure relief requirements and degree of filling requirements for non-refrigerated liquefied gases permitted for transport in portable tanks [and MEGCs].

4.2.5.2.4 Gases with critical temperatures between -50 °C and 65 °C are assigned to MEGC instruction T51. T51 provides the test pressures, pressure relief requirements and degree of filling requirements.

4.2.5.2.5 Non refrigerated gases with critical temperatures below -50 °C are assigned to MEGC instruction T60. T60 provides the test pressures, pressure relief requirements and degree of filling requirements.

4.2.5.2.6 Refrigerated liquefied gases are assigned to portable tank instruction T75.

4.2.5.2.7 Determination of the appropriate portable tank instructions
(Text of existing 4.2.4.2.5, unchanged)

4.2.5.2.8 Portable tank and MEGC instructions

T1-T33 (unchanged)
T34 (unchanged)
T50: Amend the heading to read:

"T50: PORTABLE TANK/MEGC INSTRUCTION T50

This instruction applies to non-refrigerated liquefied gases. For transport in portable tanks, the general provisions of section 4.2.2 and the requirements of section 6.6.3 shall be met. For transport in MEGCs, the general provisions of section 4.2.4 and the requirements of section 6.6.5 shall be met."

In the heading of the fourth column, add "(portable tanks only)" below "Openings below liquid level".

In the heading of the fifth column, replace "(see 6.6.3.7)" with "(see 6.6.3.7/6.6.5.5)".

In the fifth column, replace "See 6.6.3.7.3" with "See 6.6.3.7.3/6.6.5.5.3".

Insert the following two instructions:

T51 **MULTIPLE-ELEMENT GAS CONTAINER INSTRUCTION** **T51**

This MEGC instruction applies to non-refrigerated gases with a critical temperature between -50 °C and 65 °C. The general requirements of section 4.2.4 and the requirements of section 6.6.5 shall be met.

UN No.	Gases	Test pressure (bar)	Pressure relief requirements (see 6.6.5.5)	Maximum filling ratio (kg/l)
1013	Carbon dioxide	190 250	Normal	0.66 0.75
1022	Chlorotrifluoromethane (Refrigerant gas R 13)	120 250	Normal	0.9 1.1
1050	Hydrogen chloride, anhydrous	120 200	Normal	0.56 0.74
1035	Ethane	120 300	Normal	0.29 0.39
1070	Nitrous oxide	180 250	Normal	0.68 0.75
1080	Sulphur hexafluoride	70 160	Normal	1.04 1.37
1860	Vinyl fluoride, inhibited	250	Normal	0.64
1984	Trifluoromethane (Refrigerant gas R 23)	190 250	Normal	0.87 0.95
2454	Methyl fluoride (Refrigerant gas R 41)	300	Normal	0.36
2599	Chlorotrifluoromethane and trifluoromethane, azeotropic mixture (Refrigerant gas R 503)	42 100	Normal	0.2 0.66
1008	Boron trifluoride, compressed	225 300	Normal	0.715 0.86
1962	Ethylene, compressed	225 300	Normal	0.34 0.37
1859	Silicon tetrafluoride, compressed	200 300	Normal	0.74 1.1
1982	Tetrafluoromethane, compressed (Refrigerant gas R14, compressed)	200 300	Normal	0.62 0.94
2036	Xenon, compressed	130	Normal	1.24
2193	Hexafluoroethane, compressed (Refrigerant gas R116, compressed)	200	Normal	1.1
2203	Silane, compressed	225 300	Not allowed	0.32 0.41
2417	Carbonyl fluoride	200 300	Normal	0.47 0.7
2451	Nitrogen trifluoride	200 300	Normal	0.5 0.75

T60	MULTIPLE-ELEMENT GAS CONTAINER INSTRUCTION	T60
This MEGC instruction applies to non-refrigerated gases with a critical temperature below -50 °C. The general requirements of section 4.2.4 and the requirements of section 6.6.5 shall be met.		

T75 unchanged

4.2.5.3 Portable tank and MEGC special provisions

Portable tank and MEGC special provisions are assigned to certain substances to indicate requirements which are in addition to or in lieu of those provided by the portable tank and MEGC instructions or the requirements in Chapter 6.6. Portable tank and MEGC special provisions are designated using the abbreviation TP (tank provision) and are assigned to specific substances in Column 11 of the Dangerous Goods List in Chapter 3.2. The following is a list of the portable tank and MEGC special provisions:

TP1 to TP24: unchanged [except for TP20 and TP21 where the word "tanks" should be replaced with "tanks or elements"]"

CHAPTER 6.6

Requirements for the design, construction, inspection and testing of portable tanks and multiple-element gas containers

6.6.1 Application and general requirements

6.6.1.1 The requirements of this Chapter apply to portable tanks intended for the transport of dangerous goods of Classes 2, 3, 4, 5, 6, 7, 8 and 9 and to multiple-element gas containers (MEGCs) intended for the transport of non-refrigerated gases of Class 2, by all modes of transport. In addition to the requirements of this Chapter, unless otherwise specified, the applicable requirements of the International Convention for Safe Containers (CSC) 1972, as amended, shall be fulfilled by any multimodal portable tank or MEGC which meets the definition of a "container" within the terms of that Convention. Additional requirements may apply to offshore portable tanks and MEGCs that are handled in open seas.

6.6.1.2 In recognition of scientific and technological advances, the technical requirements of this Chapter may be varied by alternative arrangements. These alternative arrangements shall offer a level of safety not less than that given by the requirements of this Chapter with respect to the compatibility with substances transported and the ability of the portable tank or MEGC to withstand impact, loading and fire conditions. For international transport, alternative arrangement portable tanks and MEGCs shall be approved by the applicable competent authorities.

6.6.1.3 When a substance is not assigned a portable tank [or MEGC instruction] (T1 to T34, [T50, T51, T60 or T75]) in Column 10 of the Dangerous Goods List in Chapter 3.2, interim approval for transport may be issued by the competent authority of the country of origin. The approval shall be included in the documentation of the consignment and contain as a minimum the information normally provided in the portable tank/MEGC instructions and the conditions under which the substance shall be transported. Appropriate measures shall be initiated by the competent authority to include the assignment in the Dangerous Goods List.

6.6.5 Requirements for the design, construction, inspection and testing of multiple-element gas containers (MEGCs) intended for the transport of non-refrigerated gases

6.6.5.1 Definitions

For the purposes of this section:

Multiple-element gas container (MEGC) means a multimodal framed assembly of elements, interconnected by a manifold used for the transport of non refrigerated gases of Class 2. The multiple-element gas container includes service equipment and structural equipment necessary for the transport of non-refrigerated gases. The multiple-element gas container shall be capable of being loaded and discharged without the removal of its structural equipment. It shall possess stabilizing members external to the elements, and shall be capable of being lifted also when full. It shall be designed primarily to be loaded onto a transport vehicle or ship and shall be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, vehicles carrying multiple-element combinations (so-called battery-vehicles or battery-wagons), portable tanks , non-metallic tanks, intermediate bulk containers (IBCs) and individual elements are not considered to fall within the definition for multiple-element gas container;

Elements means

- *cylinders: pressure receptacles of a capacity not exceeding 150 litres; or*
- *tubes: seamless pressure receptacles of a capacity exceeding 150 litres and of not more than 5000 litres; or*
- *bundles of cylinders: assemblies of cylinders which are interconnected by a manifold and held firmly together;*

Manifold means an assembly of piping and valves connecting the filling/discharge openings of the elements;

Service equipment means measuring instruments and filling, discharge, venting and safety devices;

Structural equipment means the reinforcing, fastening, protective and stabilizing members external to the elements;

Design pressure means the pressure to be used in calculations required by a recognized pressure vessel code. The design pressure shall be not less than the test pressures:

Test pressure means the maximum gauge pressure of the elements during the pressure test;

Settled pressure means the pressure of the content of the elements.

Working pressure is the maximum settled pressure at 15 °C.

Leakproofness test means a test using gas subjecting the elements and its service equipment to an effective internal pressure of not less than 20% of the test pressure.

Design temperature range for the element shall be -40 °C to 50 °C for gases transported under ambient conditions. More severe design temperatures shall be considered for MEGCs subjected to severe climatic conditions;

Maximum permissible gross mass (MPGM) means the sum of the tare mass of the multiple-element gas container and the heaviest load authorized for transport;

Mild steel means a steel with a guaranteed minimum tensile strength of 360 N/mm^2 to 440 N/mm^2 and a guaranteed minimum elongation at fracture conforming to 6.6.5.3.2.3;

Filling ratio means the average mass of liquefied gas per litre of element capacity (kg/l). The filling ratio is given in MEGC instructions T50 and T51 in 4.2.5.2.8.

6.6.5.2 General design and construction requirements

[6.6.5.2.1 Elements and their closures shall be designed, calculated, manufactured, tested and equipped in such a way as to withstand all conditions to which they will be subjected during their normal use and during normal transport conditions.
Elements shall be made of steel suitable for forming. The materials shall in principle conform to national or international material standards. In choosing the material the design temperature range shall be taken into account with respect to risk of brittle fracture.
Appropriate design calculations for the shell and supporting components shall be used to ensure the safety of the receptacles concerned.
The minimum wall thickness to withstand pressure must be calculated with regard in particular to: - the calculation pressures which shall not be less than the test pressure provided in MEGC instruction T51 in 4.2.5.2.8 for each gas intended for transport;
- the calculation temperatures allowing for appropriate safety margins,
- the maximum stresses and peak stresses concentrations where necessary,
(- appropriate joint factors to the material properties).
The ratio between the maximum stress of the receptacle and the tensile strength or the ratio between the test pressure and the burst pressure of the receptacles shall be not less than 1.6 .

The requirements of this paragraph are considered to have been complied with if the following standards, as relevant, are applied:

ISO 9809	*Seamless steel gas cylinders: capacity < 150 l*
prEN ISO 11120	*Seamless steel gas cylinders: 150 l<cpa<3000l*

]

[6.6.5.2.2 Receptacles not designed, constructed and tested according to standards listed in the table above shall be designed, constructed and tested in accordance with the provisions of a technical code recognised by the competent authority. The requirements of 6.6.5.2. however shall be met.]

[6.6.5.2.3 A Quality Assurance system that complies with ISO 14600 must be in place to produce elements to be used in MEGC's whether designed to listed standards or a technical code recognised by a competent authority.]

6.6.5.2.4 MEGCs, fittings and pipework shall be constructed of materials which are:

(a) substantially immune to attack by the gas(es) intended to be transported; or

(b) properly passivated or neutralized by chemical reaction.

6.6.5.2.5 Gaskets shall be made of materials compatible with the gas(es) intended to be transported (see e.g. ISO 11114).

6.6.5.2.6 Contact between dissimilar metals which could result in damage by galvanic action shall be avoided.

6.6.5.2.7 The materials of the MEGC, including any devices, gaskets, and accessories, shall not adversely affect the gases intended for transport in the MEGC.

6.6.5.2.8 MEGCs shall be designed and constructed with supports to provide a secure base during transport and with suitable lifting and tie-down attachments.

6.6.5.2.9 MEGCs shall be designed to withstand, without loss of contents, at least the internal pressure due to the contents, and the static, dynamic and thermal loads during normal conditions of handling and transport. The design shall demonstrate that the effects of fatigue, caused by repeated application of these loads through the expected life of the multiple-element gas container, have been taken into account.

6.6.5.2.10 MEGCs and their fastenings shall, under the maximum permissible load, be capable of absorbing the following separately applied static forces:

(a) in the direction of travel: twice the MPGM multiplied by the acceleration due to gravity (g)*/;

(b) horizontally at right angles to the direction of travel: the MPGM (when the direction of travel is not clearly determined, the forces shall be equal to twice the MPGM) multiplied by the acceleration due to gravity (g) */;

(c) vertically upwards: the MPGM multiplied by the acceleration due to gravity (g)*/; and

(d) vertically downwards: twice the MPGM (total loading including the effect of gravity) multiplied by the acceleration due to gravity (g) */.

6.6.5.2.11 Under each of the forces in 6.6.5.2.8, the safety factor for the framework and fastenings to be observed shall be as follows:

(a) for steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength; or

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*/ *For calculation purposes* $g = 9.81\ m/s^2$.

(b) for steels with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof strength and, for austenitic steels, the 1% proof strength.

6.6.5.2.12 The values of yield strength or proof strength shall be the value according to national or international material standards. When austenitic steels are used, the specified minimum values of yield strength and proof strength according to the material standards may be increased by up to 15% when greater values are attested in the material inspection certificate. When no material standard exists for the steel in question, the value of yield strength or proof strength used shall be approved by the competent authority.

6.6.5.2.13 MEGC intended for the transport of flammable gases shall be capable of being electrically earthed.

6.6 5.2.14 The elements shall be secured in a manner that prevents movement in relation to the structure and the concentration of local stresses.

6.6.5.3 Service equipment

6.6.5.3.1 Service equipment shall be so arranged as to be protected against the risk of being wrenched off or damaged during handling and transport. When the connection between the frame and the elements allows relative movement between the sub-assemblies, the equipment shall be so fastened as to permit such movement without risk of damage to working parts. The manifolds, the discharge fittings (pipe sockets, shut-off devices), the stop-valves shall be protected against the danger of being wrenched off by external forces. Manifold piping leading to shut-off valves shall be sufficiently flexible to protect the valves and the piping from shearing. The filling and discharge devices (including flanges or threaded plugs) and any protective caps shall be capable of being secured against unintended opening.

6.6.5.3.2 Each element intended for the transport of toxic gases division 2.3 shall be capable of being isolated by a valve. The manifold for liquefied toxic gases division 2.3 shall be so designed that the elements can be filled separately and be kept isolated by a valve capable of being sealed. [The element(s) intended for the transport of flammable gases of division 2.1 shall be combined to groups of not more than 5000 litres, in which case each element of the MEGC shall have an isolation when the element volume is greater than 150l].

6.6.5.3.3 For filling and discharge openings of the MEGC two valves in series shall be placed in an accessible position on each discharge and filling pipe. One of the valves may be a non-return valve. The filling and discharge devices may be fitted to a manifold. For sections of piping which can be closed at both ends and where liquid product can be trapped a pressure-relief valve shall be provided to prevent excessive pressure build-up.

6.6.5.3.4 For filling and discharge openings of MEGC intended for the transport of flammable and/or toxic liquefied gases the stop-valve shall be a quick closing safety device which closes automatically in the event of unintended movement of the MEGC during filling or discharge or fire engulfment. Except for MEGCs having a capacity of not more than 1 000 litres, it shall be possible to operate this device by remote control.

6.6.5.3.5 External fittings shall be grouped together at the ends so far as reasonably practicable.

6.6.5.3.6 Each valve on a multiple-element gas container shall be clearly marked to indicate its function.

6.6.5.3.7 Each stop-valve or other means of closure shall be designed and constructed to a rated pressure not less than two thirds of the test pressure of the elements. All stop-valves with screwed spindles shall close by a clockwise motion of the handwheel. For other stop-valves the position (open or closed) and direction of closure shall be clearly indicated. All stop-valves shall be designed and positioned to prevent unintentional opening.

6.6.5.3.8 Piping shall be designed, constructed and installed so as to avoid the risk of damage due to thermal expansion and contraction, mechanical shock and vibration. All piping shall be of suitable metallic material. Welded pipe joints shall be used wherever possible.

6.6.5.3.9 Joints in copper tubing shall be brazed or have an equally strong metal union. The melting point of brazing materials shall be no lower than 525 °C. The joints shall not decrease the strength of tubing as may happen when cutting threads.

6.6.5.3.10 The rated pressure of the service equipment and of the manifold shall be not less than two thirds of the test pressure of the elements.

6.6.5.3.11 Ductile metals shall be used in the construction of valves or accessories.

6.6.5.4 Pressure-relief devices

6.6.5.4.1 MEGCs used for the transport of gases with critical temperatures below 65°C [shall/may] be provided with one or more pressure-relief devices. Every element or group of element of a multiple-element gas container that can be isolated shall [then] be fitted with one or more pressure relief-devices. The pressure-relief devices shall open automatically at a pressure between 90 and 110 percent of the test pressure. The pressure-relief devices shall be of a type that will resist dynamic forces including liquid surge (see for example CGA S-1.1-1994).

6.6.5.4.2 Pressure-relief devices [when fitted] shall be designed to prevent the entry of foreign matter, the leakage of gas and the development of any dangerous excess pressure.

6.6.5.4.3 MEGCs intended for the transport of certain non-refrigerated gases identified in instructions T50 in 4.2.5.2.8 [shall/may] have a pressure-relief device approved by the competent authority. Unless a multiple-element gas container in dedicated service is fitted with an approved relief device constructed of materials compatible with the load, such device [shall] comprise a frangible disc preceding a spring-loaded device. The space between the frangible disc and the device may be provided with a pressure gauge or a suitable tell-tale indicator. This arrangement permits the detection of disc rupture, pinholing or leakage which could cause a malfunction of the pressure-relief device. The frangible discs shall rupture at a nominal pressure 10% above the start-to-discharge pressure of the relief device.

6.6.5.4.4 In the case of multi-purpose MEGCs intended for the transport of gases with a critical temperature above 65 °C, the pressure-relief devices shall open at a pressure indicated in 6.6.3.7.1 for the gas having the highest {maximum allowable pressure of the gases} allowed to be transported in the MEGC.

6.6.5.5 Capacity of relief devices

6.6.5.5.1 The combined delivery capacity of the relief devices [when fitted] shall be sufficient that, in the event of total fire engulfment, the pressure (including accumulation) inside the elements intended for the transport of gases does not exceed 120% of the set pressure of the relief device. Spring-loaded relief devices may be used to achieve the full relief capacity prescribed in the case of gases with critical temperatures above 65°C. In the case of multi-purpose elements, the combined delivery capacity of the pressure-relief devices shall be taken for the gas which requires the highest delivery capacity of the gases allowed to be transported in MEGCs.

6.6.5.5.2 To determine the total required capacity of the relief devices installed on the elements for the transport of gases with critical temperatures below 65 °C, the thermodynamic properties of the gas have to be considered (see for example CGA S-1.1-1994).

6.6.5.5.3 To determine the total required capacity of the relief devices installed on the elements for the transport of gases with critical temperatures above 65°C, the thermodynamic properties of the gas have to be considered (see for example CGA S-1.2-1995).

6.6.5.6 Marking of pressure-relief devices

6.6.5.6.1 Every pressure relief device shall be plainly and permanently marked with the following:

(a) the pressure (in bar or kPa) at which it is set to discharge;

(b) the allowable tolerance at the discharge pressure for spring-loaded devices;

(c) the reference temperature corresponding to the rated pressure for frangible discs; and

(d) the rated flow capacity of the device in standard cubic metres of air per second (m^3/s).

When practicable, the following information shall also be shown:

(e) the manufacturer's name and relevant catalogue number.

6.6.5.6.2 The rated flow capacity marked on the frangible disk shall be determined according to CGA S-1.1-1994.

6.6.5.6.3 The rated flow capacity marked on the pressure relief devices for gases with critical temperatures above 65 °C shall be determined according to ISO 4126-1:1996.

6.6.5.7 Connections to pressure-relief devices

6.6.5.7.1 Connections to pressure-relief devices shall be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve shall be installed between the element and the pressure-relief devices except when duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always operable and capable of meeting the requirements of 6.6.5.6.

There shall be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut-off the flow from the element to that device. Vents from the pressure-relief devices, when used, shall deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving device.

6.6.5.8 Siting of pressure-relief devices

6.6.5.8.1 All pressure relief devices inlets shall under maximum filling conditions be situated in the vapour space of the elements for the transport of liquefied gases.
The devices [when fitted] shall be so arranged as to ensure that the escaping vapour is discharged upwards and unrestrictedly. For flammable and oxidising gases, the escaping gas shall be directed away from the element in such a manner that it cannot impinge upon the other elements. Protective devices which deflect the flow of gas are permissible provided the required relief-device capacity is not reduced.

6.6.5.8.2 Arrangements shall be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the MEGC overturning.

6.6.5.9 Gauging devices

6.6.5.9.1 Unless a MEGC is intended to be filled by mass/weight it shall be equipped with one or more gauging devices. Glass level-gauges and gauges made of other fragile material shall not be used.

6.6.5.10 MEGC supports, frameworks, lifting and tie-down attachments

6.6.5.10.1 MEGCs shall be designed and fabricated with a support structure to provide a secure base during transport. The forces specified in 6.6.5.2.8 and the safety factor specified in 6.6.5.2.9 shall be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.6.5.10.2 The combined stresses caused by element mountings (e.g. cradles, frameworks, etc.) and MEGC lifting and tie-down attachments shall not cause excessive stress in any element. Permanent lifting and tie-down attachments shall be fitted to all MEGCs. In no case shall mountings or attachments be welded onto the elements.

6.6.5.10.3 In the design of supports and frameworks the effects of environmental corrosion shall be taken into account.

6.6.5.10.4 When MEGCs are not protected during transport, according to 4.2.4.3, the elements and service equipment shall be protected against damage resulting from lateral or longitudinal impact or overturning. External fittings shall be protected so as to preclude the release of the elements contents upon impact or overturning of the MEGC on its fittings. Particular attention shall be paid to the protection of the manifold. Examples of protection include:

(a) protection against lateral impact which may consist of longitudinal bars;

(b) protection against overturning which may consist of reinforcement rings or bars fixed across the frame;

(c) protection against rear impact which may consist of a bumper or frame;

(d) protection of the elements and service equipment against damage from impact or overturning by use of an ISO frame in accordance with [ISO 1496-3:1995].

6.6.5.11 Design approval

6.6.5.11.1 The competent authority or its authorized body shall issue a design approval certificate for any new design of a MEGC. This certificate shall attest that the MEGC has been surveyed by that authority, is suitable for its intended purpose and meets the requirements of this Chapter and when appropriate the provisions for gases provided in instructions *T50, T51 and T60* in 4.2.5.2.8. When a series of MEGCs are manufactured without change in the design, the certificate shall be valid for the entire series. The certificate shall refer to the prototype test report, the gases allowed to be transported, the materials of construction of the manifold, the standards to which the elements are made and an approval number. The approval number shall consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic, as prescribed by the Convention on Road Traffic, Vienna 1968, and a registration number. Any alternative arrangements according to 6.6.1.2 shall be indicated on the certificate. A design approval may serve for the approval of MEGCs smaller in length, made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.6.5.11.2 The prototype test report for the design approval shall include at least the following:

(a) the results of the applicable framework test specified in [ISO 1496-3:1995];

(b) the results of the initial inspection and test in 6.6.5.13.3;

(c) the results of the impact test in 6.6.5.13.1, when applicable; and

(d) certification documents covering the elements in accordance with the applicable standards.

6.6.5.12 Inspection and testing

[6.6.5.12.1 For MEGCs meeting the definition of container in the CSC, a prototype representing each design shall be subjected to an impact test. The prototype MEGC shall be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4 g) the MPGM of the fully loaded MEGC at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads,
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600), 1992

Canadian Standards Association (CSA),
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods
(B620-1987)

Deutsche Bahn AG
Zentralbereich Technik, Minden
Portable tanks, longitudinal dynamic impact test

Société Nationale des Chemins de Fer Français
C.N.E.S.T. 002-1966.
Tank containers, longitudinal external stresses and dynamic impact tests

Spoornet, South Africa
Engineering Development Centre (EDC)
Testing of ISO Tank Containers
Method EDC/TES/023/000/1991-06]

6.6.5.12.2 The elements of MEGCs shall be initially and periodically inspected according to the requirements for receptacles. With the agreement of the competent authority or its authorized body, the hydraulic pressure test and the internal examination may be replaced by equivalent methods based on ultrasound or acoustic emission.

6.6.5.12.3 The elements and items of equipment of each MEGC shall be inspected and tested before being put into service for the first time (initial inspection and test). The initial inspection and test of a MEGC shall include a check of the design characteristics, an external examination of the MEGC and its fittings with due regard to the gases to be transported, and a pressure test referring to the test pressures according to 6.6.5.3.1. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the MEGC is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the elements and their fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

6.6.5.12.4 Thereafter MEGC shall be inspected and tested at not more than five-year intervals. (5 year periodic inspection and test) [with an intermediate periodic inspection and test midway between the 5 year periodic inspections and tests. The midway inspection and test may be performed within 3 months of the specified date]. An exceptional inspection and test shall be performed regardless of the last periodic inspection and test when necessary according to 6.6.5.13.7.

6.6.5.12.5 If the MEGCs requires dismantling for the purpose of periodic testing of the elements, the periodic inspection and test of the MEGCs after assembly shall consist of an external examination of the MEGC and its fittings with due regard to the gases to be transported, and a pressure test referring to the test pressures according to 6.6.5.3.1. The pressure test may be performed as a hydraulic test or by using another liquid or gas with the agreement of the competent authority or its authorized body. Before the MEGC is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment shall also be performed. When the elements and their fittings have been pressure-tested separately, they shall be subjected together after assembly to a leakproofness test.

6.6.5.12.6 The midway periodic inspection and test shall include external examination of the MEGC and its fittings with due regard to the gases intended to be transported, a leakproofness test and a test of the satisfactory operation of all service equipment.

6.6.5.12.7 If the MEGCs is equipped with spring loaded pressure-relief devices, the periodicity of the intermediate inspection is fixed at 2.5 years.

6.6.5.12.8 A MEGC may not be filled and offered for transport after the date of expiry of the last periodic inspection and test as required by 6.6.5.13.2. However a MEGC filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a MEGC may be transported after the date of expiry of the last periodic test and inspection:

(a) after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

(b) unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption shall be mentioned in the transport document.

6.6.5.12.9 The exceptional inspection and test is necessary when the MEGC shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the MEGC. The extent of the exceptional inspection and test shall depend on the amount of damage or deterioration of the MEGC. It shall include at least the intermediate inspection and test according to 6.6.5.13.5.

[6.6.5.12.10 The internal and external examinations shall ensure that:

(a) the elements are inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the MEGC unsafe for transport;

(b) the piping, valves, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the MEGC unsafe for filling, discharge or transport;

(c) missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

(d) all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves shall be operated to demonstrate proper operation;

(e) required markings on the MEGC are legible and in accordance with the applicable requirements; and

(f) the framework, the supports and the arrangements for lifting the portable tank are in satisfactory condition.]

6.6.5.12.11 The inspections and tests in 6.6.5.13.1, 6.6.5.13.3, 6.6.5.13.4, 6.6.5.13.5 and 6.6.5.13.7 shall be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure shall be the one indicated on the data plate of the MEGC. While under pressure, the MEGC shall be inspected for any leaks in the elements, piping or equipment.

6.6.5.12.12 When evidence of any unsafe condition is discovered, the MEGC shall not be returned to service until it has been corrected and if necessary the pressure test is repeated and passed.

6.6.5.13 Marking

6.6.5.13.1 Every MEGC shall be fitted with a corrosion resistant metal plate permanently attached to the MEGC in a conspicuous place readily accessible for inspection. In no case, the plate shall be permanently attached to the elements. The elements shall be marked with at least the information required by the pressure vessel code/standard. As a minimum at least the following information shall be marked on the plate by stamping or by any other similar method.

Country of manufacture U N	Approval Country	Approval Number	For Alternative Arrangements "AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure vessel code to which the elements are designed

Test pressure _____bar/kPa gauge */

Maximum working pressure at 15 °C_____bar/kPa gauge

Number of elements_____

Total water capacity at 20 °C _____litres of all the elements combined

Initial pressure test date and witness identification

Date and type of most recent periodic tests

Month_____ Year_____ Test pressure_____bar/kPa gauge */

Stamp of expert who performed or witnessed the most recent test

6.6.5.14.2 The following information shall be marked either on the MEGC itself on a metal plate firmly secured to the MEGC, but in no case secured to an element:

Name of the operator

Name of gas(es) permitted for transport and applicable working pressure(s)

Maximum permissible load mass gas _____kg

Maximum permissible load mass per element (liquefied gas only)_____kg

Maximum permissible gross mass (MPGM)_____kg

Unladen (tare) mass _____kg

***NOTE:** For the identification of the gases being transported, see also Part 5."*

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*/ *The unit used shall be marked.*